correlations are useful in order to identify the alert threshold associated with this kind of monitoring systems.

OC-0459

Small fields output factors and correction factors determination for a linac with circular cones

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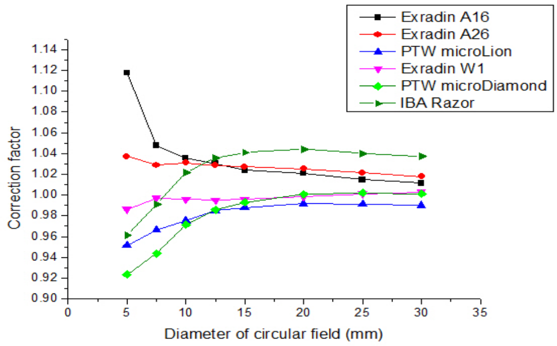
Purpose or Objective: The use of small fields is a well-established practice in stereotactic radiosurgery, although it is hard to measure with accuracy the parameters for machine commissioning. This is related to the peculiarities of highly collimated beams, such as high dose gradient, source occlusion and lack of lateral electronic equilibrium, and to the features of the detector, like dimension of the active volume and components with high-Z materials. The first goal of this work was to determine small fields output factors (OF) with several active detectors and one passive detector (Gafchromic EBT3 films) for an Elekta Axesse medical linear accelerator equipped with circular cones. The second one was to determine the correction factors for different active detectors for comparison with passive detector, as suggested in a proposed small field dosimetry formalism. Radiochromic films do not require correction factors and can be then used as reference dosimeter, as demonstrated by Bassinet et al. (C. Bassinet et al., Med. Phys. 2013, 40(7): 071725).

Material and Methods: Small fields beams, ranging from 5 mm to 30 mm in diameter, were defined using circular cones. OF measurements were performed with six active detectors (ionizing microchambers air-filled: Exradin A26, Exradin A16; ionizing microchamber isooctane-filled: PTW microLion; synthetic diamond: PTW microDiamond; plastic scintillator: Exradin W1; diode: Razor IBA) and one passive detector (Gafchromic EBT3 films).

Results: OFs measured with Exradin W1 scintillator were in excellent agreement with EBT3 films (better than 2%) . A significant underestimation between the results obtained by radiochromic films and air-filled microchamber was observed, particularly for the smallest field, up to 12% for Exradin A16. The results obtained with the PTW microLion and the PTW microDiamond indicate instead an opposite behavior: a dose overestimation for the smaller radiation fields, up to 5% and 8% for the 5 mm-diameter field for microLion and microDiamond respectively was noted. The effect decreases with field size. Razor diode was in good accordance with Gafchromic films for very small fields (diameter ≤ 10 mm), while a underestimation for larger fields has been observed. The results are shown in the following figures.

Diameter of circular field (mm)	Exradin A16	Exradin A26	PTW microLion	Exradin W1	PTW microDiamond	IBA Razor
	Correction factors					
5.0	1.118	1.037	0.951	0.986	0.923	0.961
7.5	1.048	1.029	0.967	0.997	0.944	0.991
10.0	1.036	1.031	0.975	0.996	0.971	1.022
12.5	1.030	1.028	0.985	0.995	0.986	1.036
15.0	1.024	1.027	0.988	0.996	0.993	1.041
20.0	1.021	1.025	0.992	0.998	1.001	1.044
25.0	1.015	1.022	0.991	1.001	1.002	1.040
30.0	1.011	1.018	0.990	1.003	1.001	1.037



Conclusion: The present study points out that it is crucial to apply the appropriate correction factors in order to provide accurate measurements in small beam geometry. The results show that the Exradin W1 scintillator can be used for small fields dosimetry without correction factors. The correction factors should be employed for the other detectors, in particular for field diameter smaller than 10 mm. The results furthermore demonstrate that effects such as volume averaging, perturbation and differences in material properties of the detectors should be to taken into account in order to avoid large errors in the dose determination process.

OC-0460

Common errors in basic radiation dosimetry and radiotherapy practice

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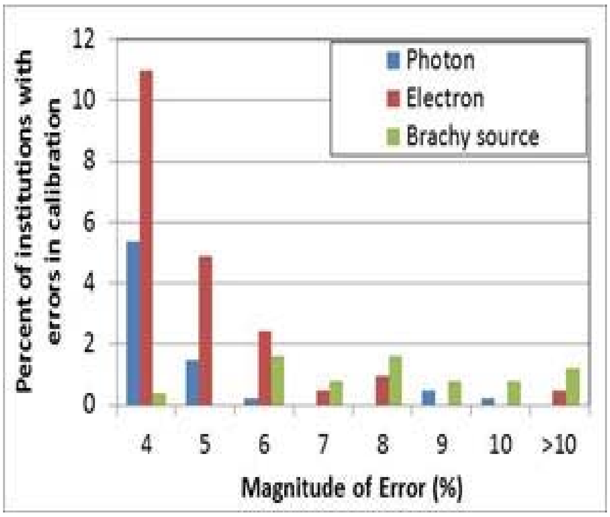
Purpose or Objective: Dosimetric errors in radiotherapy dose delivery lead to suboptimal treatments and outcomes. Identification and resolution of such dosimetric errors in support of clinical trials is the mission of the Imaging and Radiation Oncology Core office in Houston (IROC Houston). The current study reviews the frequency and severity of dosimetric and programmatic errors identified by on-site audits performed by the IROC Houston QA center.

Material and Methods: IROC Houston on-site audits evaluate absolute beam calibration, relative dosimetry data compared to the treatment planning system calculations, and processes such as machine QA. These evaluations are conducted in a uniform manner. Audits conducted from 2000-present were reviewed, which included on-site evaluations of 1020 accelerators at 409 institutions. Suboptimal conditions that led to IROC Houston recommendations (absolute dose errors >3%, relative dosimetry errors >2%, or sizeable QA deficiencies) were identified, including type of recommendation and magnitude of error when applicable.

Results: A total of 1280 recommendations were made (average 3.1/institution) (Table). The most common recommendation was for inadequate QA procedures per TG-40 and/or TG-142 (82% of institutions) with the most commonly noted deficiency being x-ray and electron off-axis constancy versus gantry angle. Dosimetrically, the most common errors in relative dosimetry were in small-field output factors (59% of institutions), wedge factors (33% of institutions), off-axis factors (21% of institutions), and photon PDD (18% of institutions). Errors in calibration were also problematic: 20% of institutions had an error in electron beam calibration, 8% had an error in photon beam calibration, and 7% had an error in brachytherapy source calibration (Figure). Almost all types of data reviewed included errors up to 7% although 20 institutions had errors in excess of 10%, and 5 had errors in excess of 20%. The frequency of electron calibration errors decreased significantly with time, but all other errors show non-significant trends with time.

Recommendation	#Inst. Receiving rec.	% of Inst receiving rec	# Linacs receiving rec	% of Linacs receiving rec
QA	337	82.4	-	N/A
Small FS dependence	132	59.2	165	50.8
Wedge (FS or depth)	134	32.8	171	16.8
Off-axis factor	87	21.3	109	10.7
Electron calibration	83	20.3	105	10.3
Photon PDD	75	18.3	100	9.8
Update calibration	70	17.1	-	N/A
Electron PDD	47	11.5	57	5.6
Temp/press correction	44	10.8	-	N/A
IGRT coincidence	3	9.4	4	8.0
Beam symmetry	34	8.3	44	4.3



Conclusion: There are many common and often serious errors made during the establishment and maintenance of a radiotherapy program that can be identified through independent peer review. Physicists should be cautious, particularly in areas highlighted herein that show a tendency for errors.

Proffered Papers: Physics 12: Treatment planning: applications I

OC-0461

Does the dosimetric advantage of prone setup persist in small-margin IMRT for gynecological cancer?

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Purpose or Objective: In order to reduce dose to the small bowel, some institutions treat patients with gynecological cancer in prone position using a small-bowel displacement device (belly board). This practice is based on dosimetric advantages found in the past for 3DCRT and/or the use of large margins. It is unknown to what extent those advantages are persistent using modern intensity-modulated delivery techniques (e.g. IMRT or VMAT) and adaptive treatment approaches with small CTV-to-PTV margins. The aim of this study is to determine the best patient setup position (prone or supine) in terms of OAR sparing for various CTV-to-PTV margins and modern dose delivery.

Material and Methods: In an IRB approved study, 26 patients with gynecological cancer scheduled for definitive (9) or postoperative (17) radiotherapy were scanned in prone and supine position at the same day. The primary CTV (proximal part of the vagina and intact cervix-uterus or vaginal cuff with paravaginal soft tissue), nodal CTV, bladder, bowel cavity, and rectum were delineated on both scans. Nine PTVs were created, each with a different margin for the primary and nodal CTV (Table 1). Pareto optimal IMRT plans with 20 equi-angular beams to be delivered with dMLC were generated using our in-house system for automated treatment planning. Previously, we demonstrated that 20 beam IMRT is superior to dual arc VMAT. For all primary/nodal margin combinations supine and prone plans were compared considering OAR dose-volume parameters, giving highest priority to bowel cavity. P-values < 0.05 were considered significant. To determine the sensitivity of the dosimetric difference to the needed margin we not only compared supine to prone treatment plans with similar margins, but also compared supine to prone plans for which the supine plans had a smaller margin than for prone. In that way, we assessed the scenario that in prone position a larger margin around the nodal CTV is needed due to increased patient setup variations.

Results: Figure 1 illustrates the comparison between supine and prone position in terms of V45Gy of the bowel cavity for all patients and margins. Prone setup was significantly superior for large margins, but not for the three smallest margin combinations, i.e. 5/5mm, 5/7mm, and 10/5mm (primary/nodal margin around CTV). The rectum Dmean was significantly lower in prone setup: 2.9 Gy ± 0.4 averaged over all margins and patients, while the bladder Dmean was lower in supine setup: 2.5 Gy ± 0.3. The significant advantage for prone setup was not present if prone setup needed a larger margin than supine. In that case the V45Gy of the bowel cavity was on average 27 cc lower in supine setup.

Margin around primary CTV (mm)	Margin around nodal CTV (mm)
5	5
5	7
10	5
10	7
10	10
10	15
20	7
20	10
20	15

Table 1. Nine tested CTV-to-PTV margin combinations

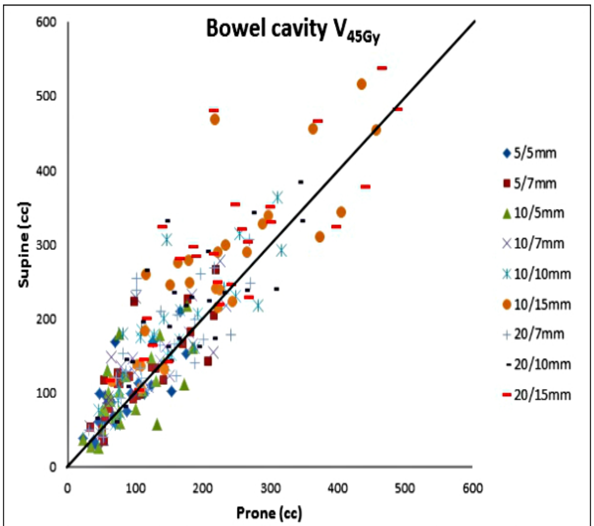

Figure 1. Comparison of bowel bag V45Gy (cc) for supine vs. prone for all margin combinations (primary CTV margin/nodal CTV margin). Prone was significantly superior to supine for primary CTV margins ⩾ 10 mm and nodal CTV margins ⩾ 7 mm